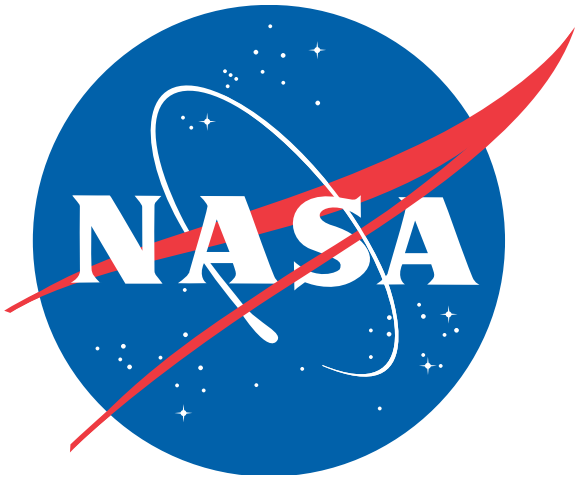

National Aeronautics and Space Administration

March 13, 1997

NRA-97-MTPE-03

RESEARCH ANNOUNCEMENT

SATELLITE REMOTE SENSING MEASUREMENT ACCURACY, VARIABILITY, AND VALIDATION STUDIES

Letter of Intent due April 17, 1997
Proposals due May 16, 1997

OMB Approval No. 2700-0087

SATELLITE REMOTE SENSING MEASUREMENT ACCURACY, VARIABILITY, AND VALIDATION STUDIES

NASA Research Announcement
Soliciting Research Proposals
For Research Commencing
On or After
September 1, 1997

NRA 97-MTPE-03

Office of Mission to Planet Earth
National Aeronautics and Space Administration
Washington, DC 20546

SATELLITE REMOTE SENSING MEASUREMENT ACCURACY, VARIABILITY, AND VALIDATION STUDIES

I. INTRODUCTION

The National Aeronautics and Space Administration (NASA) announces the solicitation of proposals for scientific investigations in support of Mission To Planet Earth (MTPE) research and the Earth Observing System (EOS) program specific to Satellite Remote Sensing Measurement Accuracy, Variability, And Validation.

NASA's Mission to Planet Earth is studying how our global environment is changing. Using the unique perspective available from space, NASA is observing, monitoring and assessing large-scale environmental processes, with current emphases on seasonal-to-interannual climate variability, land-cover and land-use changes, and research leading to the capability of modeling and detecting long-term climate change. Other key areas of MTPE research include NASA's extensive contributions to atmospheric ozone research and studies related to the monitoring and prediction of natural hazards in order to minimize the loss of human life and mitigate property damage. MTPE satellite data, complemented by aircraft and ground data, are enabling us to better understand environmental changes, to determine how human activities have contributed to these changes and to understand the consequences of such changes. MTPE data, which NASA is distributing to researchers worldwide, are essential to the formation of informed decisions about protecting our environment.

Two types of proposals are requested by this announcement. NASA's "Global Data Integration and Validation Program," an MTPE Research and Analysis (R&A) Program, is requesting proposals to determine the geophysical measurement accuracies of data from current or historical research and operational satellite sensors; also to conduct studies of the time and space variability of the derived geophysical parameters including uncertainties; and to analyze the impacts of these uncertainties on subsequent interpretations and applications. Principal emphases concern measurements in the lower atmosphere, atmospheric effects, and interactions of the lower atmosphere with the land, oceans, and stratosphere. In addition, proposals are requested for the support of activities that will enhance, supplement and/or complement activities planned by the EOS Instrument and Interdisciplinary Science Teams to characterize and validate the accuracy of remotely-sensed geophysical parameters derived by the Instrument Science Teams from measurements by EOS satellite sensors in the AM-1 time frame. See Appendix A for details and suggested research emphases on both types of proposals.

There are specific instructions for writing proposals in response to NASA Research Announcements. Please see Appendix B for necessary details.

This announcement is open to the international scientific community. Proposals from non-U.S. institutions are encouraged, but only on a "no-exchange-of-funds" basis. Specific instructions for proposals from non-U.S. institutions are included in Appendix C.

International cooperative proposals, with co-investigators from U.S. institutions participating in foreign-led proposals or with co-investigators from non-U.S. institutions on the teams of proposals from U.S. institutions, are also encouraged. These proposals

should also be on a "no-exchange-of-funds" basis for their non-U.S. elements and should identify any requirements for NASA financial support.

The present announcement is for selection of investigations to be carried out for a period of up to 3 years, although NASA reserves the option of extending the duration of some of the selected investigations, if necessary. Because MTPE/EOS is an evolving program, it is anticipated that there will be later announcements to solicit additional participation by researchers in the Earth science community. Solicitations, such as this announcement, will be issued periodically during the EOS program to replace and/or select additional studies appropriate for further phases of the EOS program (e.g. later phases of the AM series, all phases of the PM series, and other EOS missions).

All investigators selected as a result of this announcement are expected to make available to NASA all developed techniques, methods of analysis, results and data over the course of their investigation, in agreement with the MTPE/EOS Data Policy.

Although the Earth Observing System (EOS) is an approved program, the selection and deselection of instruments, as well as the scheduling of payloads on EOS flights, is subject to change based on national scientific priorities. Currently, these are established using advice from the U.S. National Academy of Science and the EOS Investigators Working Group and are subject to the guidance that NASA receives from the Executive Branch and the Congress. The U.S. Government obligation to make awards is contingent upon the availability of appropriated funds from which payment for award purposes can be made and the receipt of proposals which are determine to be acceptable by the Government for award under this announcement.

This announcement and appendices are available on the Office of Mission to Planet Earth home page on the World Wide Web. The URL address is:

http://www.hq.nasa.gov/office/mtpe/ (look under “MTPE Research Announcements”)

II. ANNOUNCEMENT OBJECTIVES

The objective of this announcement is to solicit and select investigations that will determine and/or improve the measurement accuracy of products derived from currently available satellite data for use in research studies and geophysical variability analyses or which will improve the validation of satellite-derived products produced by EOS Instrument Science Teams from measurements made by EOS sensors in the AM-1 time frame. The NASA Research and Analysis (R&A) and EOS programs are complementary components of NASA's Mission to Planet Earth (MTPE). In each instance, investigations are sought that will characterize and validate the accuracy of the data products and/or lead to the improvement in accuracy of those products.

III. PROPOSAL RESEARCH TOPICS

Two types of proposals are requested by this announcement:

(1) Type 1 proposals, as part of the NASA R&A program, are meant to characterize

and/or improve the accuracy of geophysical parameters derived from satellite remote sensing for use in measuring and evaluating interseasonal to interannual trends and/or changes in the atmospheric, oceanic, and land surface environments. Focus should be on near-term activities and on validation of the actual accuracies that can now be achieved by current operational and research sensors. Relevant research topics for Type 1 proposals are given in Appendix A. Priority will be given to research areas which are not covered by other recent NASA Research Announcements such as the Land-Cover and Land-Use Change (LCLUC), the Sensor Intercomparison and Merge for Biological and Interdisciplinary Oceanic Studies (SIMBIOS), and the Solid Earth and Natural Hazards Research and Applications Announcements. Priority also will be given to high-quality scientific proposals that seek to study and validate the data/product accuracy of geophysical parameters which are or will be measured in the next few years of preliminary climatological studies leading to the era of EOS measurements. Valuable data for studies of this type has been collected in the NASA-NOAA Pathfinder Program and archives of data from available geostationary satellites.

(2) Type 2 proposals are for activities that support, enhance, supplement or complement data product validation activities planned by the EOS Instrument and Interdisciplinary Science Teams in the AM-1 time frame. Specifically, this solicitation is limited to validation of data products derived from measurements by the ASTER, CERES, MISR, MODIS and MOPITT sensors on the EOS AM-1 satellite (6/98); the CERES and LIS instruments on the Tropical Rainfall Measurement Mission (TRMM, 11/97); the SAGE III sensor on METEOR (8/98). Planned launch dates are noted in parentheses. Validation activities seek to characterize and/or improve the accuracy of the data products. Data products produced in the AM-1 time frame comprise a significant contribution to the basic 24 types of EOS Measurements (These are listed at the following Internet address: http://eospso.gsfc.nasa.gov/eos_homepage/pubs.html). Besides the elemental radiance measurements, data products will be produced that include geophysical parameters relating to clouds, aerosols, radiative balance, terrestrial surfaces, maritime surfaces, and the carbon cycle. Relevant research topics and important programmatic considerations for Type 2 proposals are given in Appendix A.

We estimate that the initial NASA funding levels in FY 1997 will be approximately $2 million for the MTPE R&A Program, i.e., Type 1 proposals; and approximately $3 million for the EOS Validation Program, i.e., Type 2 proposals. Subsequent EOS Validation funding levels are anticipated to be approximately $4M/yr. This NASA Research Announcement will support approximately 50 new proposal awards, with annual budgets in the $50,000-$200,000 range and a nominal award duration of three years (subject to annual review). The selection of any proposals is contingent upon the availability of funds. Since the selection of these proposals is being made late in FY97, some approved proposals may be funded initially with FY98 funding, as appropriate.

Since some of the proposals in response to this anouncement may desire the use of NASA-sponsored aircraft, it should be noted that this resource is used by all NASA R&A and EOS-related programs, and, hence, must be planned carefully in a cooperative manner in order to insure the maximum amount of science return for the available resources. The NASA Airborne Science Flight Program has been in transition over the last few years and now requires increased coordination as well as flight hour costs to be provided by the

researcher. The planning points-of-contact and flight hour costs for FY97 were provided to potential aircraft users in May, 1996. We are providing the substance of that guidance here in Appendix E for your assistance in scoping your FY98 and beyond airborne requirements in the proposals.

IV. PROPOSAL SUBMISSION AND SELECTION SCHEDULE

All prospective proposers are strongly encouraged to submit a letter of intent to propose to NASA in response to this announcement by the close of business on April 17, 1997. This letter will help to expedite NASA's planning for the peer review. The letter of intent may be submitted electronically through the Internet by completing the forms at URL: *http://www.mtpe.hq.nasa.gov/LOI/form.html***.** You are urged to use these electronic letter of intent forms unless you do not have access to the Internet. In that case, we will accept a FAX copy sent to 202-554-3024 with the following information:

- PI and CoI names and addresses, (including Zip + 4);
- NRA Identifier;
- Title of proposal;
- Type of proposal (Type 1 or Type 2);
- Telephone number;
- Fax number;
- E-mail address; and
- A brief summary of your proposal including any plans for aircraft usage (Please limit this summary to no more than 3000 characters).

All proposals from investigators from the U.S. and other countries will be received and evaluated by NASA. All proposals submitted in response to this announcement are due, at NASA Headquarters, by the close of business on May 16, 1997. Late proposals will not be considered for review and funding, unless it is judged to be in the interest of the U.S. Government. All proposals submitted to NASA in response to this announcement must have a completed cover-sheet-form and information on current and pending research support from all other sources (see Appendix D) attached.

A complete proposal schedule is given below:

Letter of Intent to Propose due - April 17, 1997

Proposals due at NASA Headquarters - - - - - - - - - - - - - - - - - May 16, 1997

Peer Review by Mail -May 16 – July 3, 1997

Meeting of Peer-Review Panels- -- - -July 15 - July 18, 1997

Announcement of Final Selections - - - - - - - - - - - - - - - - - - - Aug. 4, 1997

Additional information is provided in Appendices A-F of this Announcement. Appendix A provides technical and programmatic information concerning the scope, foci, and

objectives of the scientific activities covered by this announcement, as well as specific instructions for proposers to this announcement. Appendix B contains the instructions needed for preparation of solicited proposals in response to this announcement. Appendix C provides guidance for international participation. Appendix D provides the list of required declarations and the proposal cover sheet. Appendix E provides information concerning airborne science requirements points-of-contact and FY97 flight costs for planning purposes. Appendix F contains a list of acronyms used.

Identifier: NRA 97-MTPE-03

Submit proposals to: MTPE/EOS NRA
Code Y
400 Virginia Avenue, SW
Suite 700
Washington, DC 20024
(For overnight delivery purposes only,
the recipient telephone number is 202-554-2775)

Number of Copies Required: 10

Selecting Official: Director, Science Division
Office of Mission to Planet Earth
NASA Headquarters

Point of Contact for Additional Information On MTPE Global Data Integration and Validation: Dr. James Dodge, Program Manager
Mail Code YS
NASA Headquarters
Washington, DC 20546
Tel.: (202) 358-0763
Fax: (202) 358-3098
jdodge@mail.hq.nasa.gov

Point of Contact for General Information on EOS Validation Activities: Dr. David O'C. Starr
NASA Goddard Space Flight Center
Code 913
Greenbelt, MD 20771
Tel.: (301) 286-9129
Fax: (301) 286-1759
starr@climate.gsfc.nasa.gov

Additional information about any of the specific areas may be obtained by referencing the detailed points of contact identified in Appendix A.

Your interest and cooperation in participating in this opportunity are appreciated.

ORIGINAL SIGNED BY

William F. Townsend
Acting Associate Administrator for
Mission To Planet Earth

Enclosures:

Appendix A. Technical Description and Specific Guidelines for Proposers
Appendix B. Instructions for Responding to NASA Research Announcements
Appendix C. Guidelines for International Proposals
Appendix D. Proposal Cover Sheet, Formats, Forms, And Required Declarations
Appendix E. Airborne Science Points-of-Contact and Flight Cost Estimates
Appendix F. List of Acronyms Used in this Research Announcement

Appendix A

Technical Description and Specific Guidelines for Proposers

A.I Type 1 Proposals - MTPE Global Data Integration and Validation Program: Studies of Satellite Measurement Accuracy, Variability, Trends, and Implications

A.I.1 - Background

The Global Data Integration and Validation Program is one of the core science programs within the Science Division of the Office of Mission to Planet Earth. It has Research and Applications (R&A) goals of supporting the interdisciplinary interpretation of remote-sensing data from a variety of U.S. and foreign satellites in order to validate remote sensing algorithms and to study the time and space variations of the derived geophysical parameters. The scientific discipline focus has been primarily atmospheric remote sensing in the lower atmosphere with associated interactions involving heat, mass, and momentum exchanges with adjoining regions including the ocean and land surfaces, as well as with the stratosphere. Recent programmatic foci have involved global precipitation algorithm intercomparisons, support of NASA-NOAA Pathfinder Data analyses of variability, intersatellite calibration continuity to allow climatological interpretation of data, global and regional water vapor variability studies, global rainfall and lightning distributions, water vapor radiative feedback studies, and aircraft/surface validation measurements in support of satellite temperature, moisture, and radiation measurements. Type 1 proposals do not need to be limited to these current scientific
foci; however, proposers should try to prevent overlap with ongoing work in other NASA core R&A programs.

In view of programmatic changes that result from evolving technologies and scientific priorities, it will be difficult to maintain a long series of identical sensors in orbit to measure the Earth's physical, dynamical, and chemical interactions. We must be able to use a variety of available and changing satellite sensors, possibly in different orbits and with different sampling characteristics. All this emphasizes the need for integrating all available similar data, yet maintaining a methodology that identifies and measures the uncertainties with each type of observation and quantifies the final products and the impacts on resultant interpretations.

A.I.2 – Guidance to Proposers

We wish to be able either to measure or to model regional and global trends accurately enough to support any environmental management decisions which might be suggested. This means that measurement accuracy (or uncertainty, since absolute accuracy is difficult to validate globally) should be of prime consideration. Measurement uncertainty may be approached through carefully planned remote sensing data intercomparisons using all available validating data to minimize biases. The rationale behind conducting additional time and regional variability studies, once measurement accuracy has been established, is to have a climatological variability background to gauge the significance of apparent short-term trends in the measurements.

While one strategy of establishing remote sensing measurement accuracy is to make direct comparisons with a large number of surface-based, airborne, or other in-situ observations; the cost of making a large enough set for statistical adequacy may be prohibitive. It is expected that proposers will make use of all available similar satellite observations for intercomparisons and already-planned field experiments as a source of multiparameter environmental studies. Support for a limited number of special and/or supplemental ground truth observations will be considered provided that there is adequate justification.

Going beyond actual measurement intercomparisons, researchers are encouraged to conduct detailed uncertainty analyses of their end-to-end analysis systems in order to be able to trace the effects of improvements in measurement accuracy. This methodology will become more and more important as trade-offs between sensors of improved accuracy vs. new observables are being considered. Proposers should include an initial estimate of their sources of uncertainty.

A.I.3 – Remote Sensing Foci

The remotely-sensed observables which are being considered for highest priority include atmospheric water vapor burden, 3-D structure of temperature and moisture, precipitation distribution, atmospheric moisture fluxes, distribution of heavy precipitation due to severe storms, distribution and evolution of drought regions, snow depth distribution, land surface wetness, ocean surface temperature, ocean surface winds, lightning distribution as an indicator of regional or global trends, diurnal cloudiness and cloud layering variability, and atmospheric path effects due to moisture and/or aerosols, severe storm track and distribution as an indicator of climatic and dynamic variability, and surface energy fluxes, especially as modified by water vapor long-wave absorption effects. These measurements or remotely-observable quantities cover ten of the 24 EOS measurement categories, and stress currently available observations as well as observations which will be made with the early EOS and TRMM flights.

A.I.4 – Proposal Emphases

Proposals should stress the determination of measurement accuracy or uncertainty for specific use in improving the understanding of quantitative scientific questions such as the regional behavior of the atmospheric water cycle, or for improving the prediction accuracy of interseasonal moisture or drought forecasts, or for establishing the reality of storminess trends which exceed climatological expectations. The scientific question, hypothesis, or application should be stated in such a way that the effects of remote sensing uncertainties can be understood and the impact of improved accuracies specifically determined.

The pragmatic necessity of using data from multiple satellites as well as surface sources, makes the careful handling of different data types of prime importance to these studies. The analysis of data from multiple sources is encouraged. With much of the above scientific emphases being on water in each of its various states, it is likely that the analyses of passive and perhaps active microwave data will be necessary. With variables that change rapidly in time, the likelihood is that geostationary meteorological satellite data will be necessary to study the diurnal or faster variability.

In many cases, the data required for these studies already resides in NASA or NOAA

data centers, and can be obtained directly. All costs of anticipated data purchases should be included in the proposals, as well as any special observing or computing requirements associated with handling substantial amounts and time series of data.

In other cases, where a particular region is being studied, some new observations and/or satellite data acquisition might be necessary. Please indicate all such requirements. A limited amount of funding will be used for direct satellite data acquisition, where necessary, such as for foreign regions, foreign satellites, or proposed applications that require immediate data for nowcasting or warning algorithm development.

It is also desirable to understand the impacts of remote sensing inaccuracies or uncertainties. Approximately 20-25% of the funding for Type 1 proposals will be allocated for quantitatively estimating these impacts. One approach could be to submit a joint proposal with that amount for a modeling or forecasting group to analyze the impacts of the determined uncertainties.

A.I.5 – Suggestions for Types of Studies

-Regional variability studies and trends, including an emphasis on weather-related hazards
-Algorithm intercomparison studies
-Theoretical measurement accuracy and validation measurements
-Intersatellite derived product intercomparisons
-Multiple or time series satellite algorithm development
-Uncertainty analysis using basic physical and system equations
-Global trend analysis using available long-term data sets such as Pathfinder and GCM reanalyses
-Physical process measurement validation
-EOS precursor or operational satellite sensor validation
-Development of advanced physical-statistical validation methodology
-Model impact analysis of remote sensing measurement errors
-Establishment of statistical criteria for accuracy with multiple satellite sensors, orbits, observation times, and spectral coverages
-Removal of satellite data artifacts and post-observation recalibration
-Real-time calculation of direct broadcast data products and uncertainties

A.I.6 - Measurement Sources

-Available data sets in data centers or on the Internet
-Specially scheduled satellite observations
-Limited additional satellite data purchases
-Near-simultaneous satellite direct broadcast data to ground stations
-Planned field experiments or sites for EOS validation
-Special aircraft remote sensing and in-situ observations
-Limited supplemental radiosonde, dropsonde, XBT, or surface observations for validation
-Radar, profiler or other surface remote measurements
-Operational satellite direct transmissions and data archives
-Coordinated regional measurement field programs such as GCIP, LBA(not yet approved), BALTEX, ARM sites, GBSRN, GVAP, BOREAS, FIFE

A.I.7 - Relationship to Current and Future Operational Satellite Accuracy Determination

-Studies related to GOES 8/9 measurement accuracy
-Studies of NOAA-K and other polar series satellites
-Use of DMSP sensors including SSM/I, SSM/T and T2, OLS, and SSM/IS
-Studies with precursor NPOESS sensor combinations or surrogates
-Studies with foreign satellite data including those from ADEOS, ADEOS-II, ERS-1/2, JERS-1, and possibly FY-2 from direct reception

A.I.8 - Priority World Regions for Validation Studies

- N. Pacific Basin and Southern Oceans (Cloud and storm regions, warm pool, island interactions and impact studies)
  JERS-1, ADEOS, ERS-1/2, GMS, NOAA, DMSP, GOMS, LANDSAT-5
- North American Monsoon Region and GCIP Regions (Atmospheric moisture)
  GOES-8, NOAA, DMSP
-Indonesia and S. China Sea (Asian Monsoon region)
  TRMM, FY-2, GMS, NOAA, DMSP
-Brazilian Rainforest and Amazon Basin during LBA (Regional atmospheric moisture fluxes, precipitation)
  GOES-8, NOAA, DMSP
-Middle East and S. Africa (Drought and desert regions)
  NOAA, DMSP, METEOSAT
-Polar Regions (Atmospheric moisture and snowfall over ice)
  NOAA, DMSP

A.II Type 2 Proposals - EOS Validation during the AM-1 Time Frame

Proposals are solicited for activities that support, enhance, supplement or complement data product validation activities planned by the EOS Instrument and Interdisciplinary Science Teams in the AM-1 time frame. Specifically, this solicitation is limited to validation of data products derived from measurements by the ASTER, CERES, MISR, MODIS and MOPITT sensors on the EOS AM-1 satellite (6/98), the CERES and LIS instruments on the Tropical Rainfall Measurement Mission (TRMM, 11/97) and the SAGE III sensor on METEOR (8/98), where the planned launch dates are as noted. Validation activities seek to characterize and/or improve the accuracy of the data products. The overall goal of this program is to quantify and improve the accuracy and provide validation for remote sensing observations and retrieved geophysical parameters used for evaluating regional and interseasonal to interannual changes and trends in the atmospheric, land, and oceanic environments.

Investigations are solicited that consider EOS data products in the following categories:

1) Instrument level data products, i.e., calibrated and geolocated data (usually radiances);

2) Fundamental geophysical parameters (derived from Level 1 products) retrieved at the space and time scales of the individual satellite measurements, i.e., instantaneous observations for the instrument field of view (FOV);

3) Gridded and mapped data on uniform space and time scales with global coverage (derived from Level 1 and 2 products); and

4) Higher order data products produced by combining satellite remote sensing measurements of fundamental geophysical parameters, usually incorporating model calculations and/or other observations or analyses, and often on uniform space and time grids (derived from Level 2 and 3 products).

Priorities for scientific data product validation are based on the sequential and dependent nature of the EOS data production chain. For example, the Level 2 MODIS cloud mask and aerosol data products are used by the MODIS team and by several other teams for screening clouds and for accomplishing the atmospheric correction required to produce various products describing the Earth's surface, such as surface reflectivity. Given the limited available resources, higher priority will be given initially to studies of the more fundamental data products on which the accuracy of higher order products inherently depend. It is also of importance to validate remote geophysical measurements which can be made by more than one sensor.

Validation of the instrument level radiance products, i.e., validation of the instrument calibration - often called vicarious calibration, is of prime importance to the EOS Validation Program. Correction for atmospheric effects, including aerosols and gases as well as the functionality of cloud masks, is key to the accuracy of whole families of data products and, thus, is also of very high priority. Temperature and reflectance parameters associated with terrestrial and maritime surfaces and clouds are also quite fundamental as are the basic physical characterizations derived from these parameters, such as, for

example, spectral vegetation indices and land cover, chlorophyll-a and coccolith concentrations, cloud optical depth and particle size, and trace gas concentrations. During the initial period after launch, the highest priority for EOS science data validation will be given to Level 1 and Level 2 products, called fundamental remote sensing products, with emphasis on products that have multi-instrument data product impacts. Comparative studies of similar remote sensing products are encouraged, e.g., ASTER vs. MISR vs. MODIS or EOS data products vs. comparable products produced from operational or other research satellites. As the data products through Level 2 mature, validation activities for Level 3 and Level 4 products will increase in priority.

The EOS Validation Program presently includes substantial planned efforts to be conducted by the EOS Instrument and Interdisciplinary Science Teams. It is not the intention here to support investigations that duplicate or compete with those existing investigations. Investigations that support, enhance, supplement and/or complement the planned activities are desired. For example, if a strong and relatively comprehensive vicarious calibration activity is already incorporated in the planned activities of a particular instrument team, then proposals in that area would not have a high priority here despite the inherent value placed on such an activity. In particular, the Instrument Science Team Validation Plans include substantial airborne field experiment activities. These activities are primarly funded from the individual Instrument Science Team budgets and not through this NRA. Although some of the proposed missions are independent in character, many are coordinated with field experiments supported by other NASA R&A Programs or other agencies. While not precluded, proposals for additional flight programs utilizing NASA aircraft resources to validate the EOS data products will be evaluated in the context of the existing EOS Validation flight program. Thus, it is highly recommended that proposals requiring NASA aircraft resources be coordinated with existing Instrument Science Team plans.

Proposers must, therefore, be knowledgeable of the specific EOS data products and corresponding Instrument Science Team validation plans for the AM-1 time frame. Brief synopses of the validation plans, including planned and desired elements, are given in Appendix A.III along with points-of-contact for the various Instrument Science Team investigations. The full Instrument Science Team Data Validation Plans and more detailed summaries, as well as other information about the EOS Validation Program and related national and international resources and facilities, may be found on the EOS Project Science Office home page. The URL address is:

http://eospso.gsfc.nasa.gov/ (look under Validation, then Documents).

Additional information on EOS, the Instrument Science Teams and the data products may also be obtained from the EOS Project Science Office home page (look under EOS Publications), the EOS Reference Handbook, the MTPE EOS Data Products Handbook, and the Algorithm Theoretical Basis Documents (ATBD's) produced by the Instrument Science Teams will be of particular utility. EOS Interdisciplinary Science Teams also plan to contribute to the validation of EOS data products. Some information on these activities may be found on the EOS Project Science Office home page (look under Validation, then Documents). Additional information may be obtained by contacting those investigators. Contacts for EOS Interdisciplinary Science investigations may be found on the EOS Project Science Office home page (look under EOS Investigations).

A very strong collaborative working relationship is desired between EOS validation investigations funded through this solicitation and the appropriate EOS Instrument Science Teams. *Where appropriate, successful investigators will become Associate Members of an Instrument Science Team and will be expected to participate fully in and be responsive to the activities and needs of that team.* This will facilitate investigator access to the satellite data at an early stage and increase the relevance and rapid impact of the validation activities funded here. Contact between prospective investigators and the Instrument Science Teams is highly encouraged to assist in the formulation of appropriate proposals. While members of the Instrument and Interdisciplinary Science Teams may respond to this solicitation, *a principal motivation of this solicitation is to bring new resources, especially human resources and expertise, to bear on the task of validating the EOS data products.*

The intention to forge an integrated EOS science data validation effort, as noted above, should not be construed as discouraging proposals that seek to apply innovative, cost-effective approaches to the task of EOS science data validation that may not be presently recognized by the Instrument Science Teams.

For the EOS Validation Program, proposals are particularly solicited for providing supplementary support to the development of networks of test sites for enhancing EOS data product validation activities. *Emphasis will be given to augmenting existing networks with measurements to validate EOS data products rather than developing new networks.* Proposals to provide specific correlative data products, e.g., as a data buy, in support of validation of EOS data products and Instrument Science Team validation activities will be considered. Proposals to provide data management functions with respect to such data will also be considered though it is expected that only a very limited number of such proposals will be accepted.

Proposals involving collection of correlative measurements for use in validation and intercomparison studies must satisfy the following criteria:

a) Investigators must commit to participation in community activities to define appropriate measurement and calibration protocols for field measurements and adhere to those protocols, and

b) Investigators must commit to participate in community calibration activities for field measurement sensors.

It is expected that the EOS Calibration Scientist, Instrument Science Teams, EOS Investigator Working Group or other components of EOS, will help organize such community activities with respect to field measurements. Budgets should account for travel to participate in such community activities, i.e., meetings and travel to calibration facilities.

In addition,

c) Investigators must commit to providing their correlative measurements in a timely manner with appropriate quality control and documentation to the appropriate Instrument Science Teams where it will be made publicly available from either their Science Computing Facility (SCF) or alternatively from an appropriate EOS Distributed Active Archive Center (DAAC).

It is expected that all validation or correlative measurements obtained by investigators funded here or by the Instrument and Interdisciplinary Science Teams will be publicly accessible though an SCF or DAAC validation home page for each specific instrument or EOS data product. The EOS Validation Program will maintain an on-line catalog of all such data. The purpose of this policy is to further the scientific benefit derived from EOS validation activities by providing data access to the broadest scientific community.

A.III EOS Validation Overviews for the AM-1 Time Frame Missions

A.III.1 ASTER Validation Overview

The Advanced Spaceborne Thermal Emission And Reflection Radiometer (ASTER), instrument on the EOS AM-1 spacecraft will provide high spatial resolution (15- to 90-m) multispectral images of the Earth's surface and clouds in order to better understand the physical processes that affect climate change. While the Moderate-Resolution Imaging Spectroradiometer (MODIS) and Multi-Angle Imaging Spectro-Radiometer (MISR) will monitor many of the same variables globally and on a daily basis, ASTER will provide data at a scale that can be directly related to detailed physical processes. These data will bridge the gap between field observations and data acquired by MODIS and MISR, and between process models and climate and/or forecast models. ASTER data can be used to study in more detail the quantities and processes such as surface properties, elements of surface energy and water balance, and cloud properties that are monitored globally by MODIS and MISR at moderate resolution.

ASTER Standard Data Products are:

- Registered radiance at sensor
- Decorrelation stretch
- Brightness temperature
- Surface radiance - VNIR, SWIR
- Surface reflectance - VNIR, SWIR
- Surface radiance - TIR
- Surface kinetic temperature
- Surface emissivity
- Polar surface and cloud classification
- Digital Elevation Model

The ASTER team plans to establish the scientific validity of the data by preflight measurements, computer simulations, and by in-flight validation activities, especially emphasizing vicarious calibration field missions. An airborne MODIS-ASTER simulator instrument (MASTER) is presently under construction and will likely fly prior to the launch of AM-1.

As part of the field missions, calibration and validation activities are planned at a number of test sites. Candidate test sites in the U.S. are: Lunar Lake and Railroad Playa in Nevada; Lake Tahoe in California and Nevada; White Sands, New Mexico; and Edwards Air Force Base, Ivanpah Playa and the Salton Sea in California. Measurements by instruments at the surface and on aircraft are planned for the following parameters: spectral radiance and total irradiance at the surface; surface properties (e.g., spectral reflectance, spectral bidirectional reflectance distribution function, and spectral emissivity and temperature); atmospheric properties (e.g., spectral optical depth, water vapor, ozone, aerosol optical depth, aerosol size distribution and Angstrom coefficient, phase function, and complex index of refraction); and meteorological profiles of temperature and relative humidity.

The expectation is that the vicarious calibration activities will be conducted jointly with other EOS Instrument Science Teams, and possibly other national or international instrument teams, at some of these sites. In addition, participation in field measurement

actvities of opportunity, such as by other EOS teams, at different sites will be used to extend the dynamic range of surface types used for validating the data products.

The ASTER team has not identified any specific needs or requirements for additional validation activity or measurements beyond what is presently planned by them. However, international participation in ASTER vicarious calibration field missions so as to enable cross calibration of instruments on multiple satellites is desired. Proposals to support such an activity as well as proposals from U.S. investigators to provide measurements that supplement or significantly enhance the planned ASTER vicarious calibration field missions will be considered.

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A.III.2 CERES Validation Overview

The Clouds and the Earth's Radiant Energy System (CERES) is scheduled for launch on TRMM and on the EOS AM-1 platform. CERES will provide an accurate and self-consistent cloud and radiation database. Cloud and radiation flux measurements are fundamental inputs to models of oceanic and atmospheric energetics, and land surface energy balance and hydrology, as well as for estimation of the net primary productivity of terrestrial and oceanic ecosystems. Knowledge of the energy budget of the atmosphere and surface will also contribute to improvements in extended range weather forecasting.

For CERES there are five major data types to validate**:**

1) Instrument broadband radiances
2) Top of atmosphere radiative fluxes
3) Cloud properties
4) Surface radiative fluxes
5) Atmosphere radiative fluxes

The instrument radiances, top-of-atmosphere (TOA) radiative fluxes, and cloud property retrievals are fundamental remote sensing data products (Level 1-2) while the surface and atmospheric flux products are higher order data products requiring more extensive application of models as well as incorporation of data from other EOS and non-EOS sources. In the case of TRMM, CERES cloud products are derived from measurements obtained by the VIRS (Visible and Infrared Sensor) and TRMM Microwave Imager (TMI). For the AM-1 satellite, the CERES cloud products are derived from radiance measurements provided by MODIS.

The CERES Team plans a full range of data validation approaches including:

1) Theoretical sensitivity studies *(radiative modeling)*
2) Comparison to pre-launch satellite data surrogates *(ERBE/AVHRR/HIRS)*
3) Checks of internal data consistency *(e.g. view zenith dependence)*
4) Comparison to correlative measurements from surface sites, including surface radiative fluxes and measurements of atmospheric (cloud and aerosol parameters
5) Comparison with other EOS satellite data (MISR, ASTER, GLAS, EOSP)
6) Comparison to correlative measurements obtained from field campaigns

The priority of the various planned validation strategies for the CERES data products are given in the matrix below.

Data Product / Validation Strategy Matrix
(1 = Critical; 2 = Important; 3 = Useful)

Validation Technique	Radiance	TOA	SFC	Atmosphere	Cloud
Theoretical sensitivity studies	2	3	3	2	2
Pre-launch satellite surrogate	2	2	2	3	2
Internal consistency	2	1	3	2	2
Surface Sites			1	1	1
Other EOS-era Satellite Data	3	2	1	1	1
Field Campaigns			2	2	2

The CERES Science Team relies on the on-board calibration system as the key element in establishing the accuracy of their most fundamental products (instrument broadband radiances). Building on the experiences gained from the ERBE (Earth Radiation Budget Experiment) missions, the CERES team has strong efforts planned to validate their TOA flux products using approaches 1-3.

The CERES Team makes use of the MODIS cloud mask and performs an independent retrieval of cloud properties using MODIS radiance data products. The cloud products are used in combination with other information, such as global data assimilation products, to

calculate surface and atmospheric flux products using self-consistent radiative transfer models.

For the validation of the surface flux data products, CERES desires well-calibrated radiation data from surface sites. Current sites acquiring such data include sites of the Baseline Surface Radiation Network (BSRN), the Surface Radiation Budget Network (SURFRAD), the Global Energy Balance Archive (GEBA), the Atmospheric Radiation Measurement (ARM) program, and the Walker Tower project of CERES. The value of surface flux data are greatly enhanced by acquisition of coincident sunphotometer data enabling definition of the aerosol and water vapor loading affecting the observed surface fluxes. Knowledge of the angular distribution of the upwelling radiation field under a variety of surface conditions is also important.

Expansion of networks presently providing quality surface radiation data to yield greater global coverage is desired. There is significant commonality between the requirements of CERES and those of MODLAND (described in A.III.4.c) for surface measurements. Given limited resources and the strong desire to promote synergy between disciplines, additional surface radiation sites located in biomes not presently represented by the available networks are of particular interest. Similarly, enhancement of an existing site, e.g., addition of a sunphotometer, is favored when the location is representative of a significant biome. Standardization of instrumentation, calibration and data access are significant issues affecting the utility of such data for validation.

The EOS Project Science Office presently funds a sunphotometer network (AERONET). Participation in AERONET and its community database activities is encouraged for any additional sunphotometer observations collected for EOS validation. Observations of the local bidirectional distribution of reflected solar radiation (or to a lessor extent, the angular distribution of emitted infrared radiation) are desired by CERES and MODLAND for the surface radiation sites. Establishing the representativeness of traditional approaches to BRDF measurement has proven problematic. Innovative cost effective approaches that address this requirement are encouraged.

Given the inherent importance of the cloud property retrievals for derivation of the surface and atmospheric fluxes, investigations enabling validation of the cloud property retrievals are desired. The CERES team has adopted a philosophy wherein much greater priority is placed on correlative measurements obtained systematically over extended periods (versus during field experiments of limited duration). This philosophy is complementary to the philosophy adopted by the MODIS-Atmosphere group (described in A.III.4.b) where greater emphasis is placed on cloud measurements obtained during field missions.

CERES has developed the CAGEX (CERES-ARM-GEWEX Experiment) strategy as a central element in their efforts to validate their cloud surface flux and cloud products. Data collected by the Atmospheric Radiation Measurement (ARM) program and the Global Energy and Water Experiment (GEWEX) are combined with satellite and global analyses, such as data assimilation products, and placed in an on-line database to be used for validation studies. ARM presently operates a super surface site in Oklahoma and is presently implementing a surface site on the north slope of Alaska and multiple sites in the tropical western Pacific Ocean. These sites provide a variety of remote sensing observations in addition to basic observations of surface radiative fluxes and general

meteorological conditions on a fairly continuous basis. Of particular importance to CERES are cloud observations obtained by short-wavelength (mm) radar and cloud and aerosol observations obtained by lidar. Additional cloud property validation sites, especially in different climatological regimes, are desired. EOS seeks to take advantage of presently existing capabilities to the extent possible. Funding to create additional super sites from scratch is simply not available. The value of a cloud property validation site is significantly enhanced if it also meets the requirements for a surface radiation flux site as noted above. Again, standardization and data management aspects are important issues affecting the utility and value of the data for CERES.

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A.III.3 MISR Validation Overview

The Multi-Angle Imaging Spectroradiometer (MISR) instrument on the EOS AM-1 spacecraft will acquire systematic multi-angle (26.1, 45.6, 60.0, 70.5° forward and aft of nadir), multi-spectral (443, 555, 670, 865 nm) imagery for global monitoring of top-of-atmosphere and surface albedos and measurement of the shortwave radiative properties of aerosols, clouds, and surface scenes in order to characterize their impact on the Earth's climate.

MISR Standard Data Products are:

- Level 1 data products
  - Calibrated and geo-located radiances
- Level 2 data products
  - Top-of-atmosphere and cloud products
    - TOA albedo and bidirectional reflectance factor (BRF)
      - Cloud mask

Reflecting level reference altitude and altitude-binned cloud fraction

- Aerosol and surface products
  - Aerosol optical depth and compositional model identifier
  - Directional hemispheric reflectance, hemispheric reflectance, BRF and FPAR for land surfaces
  - Water-leaving equivalent reflectance and phytoplankton pigment concentration for tropical oceans

Gridded global radiation, cloud, aerosol and surface products will be generated from the corresponding Level 2 products. In addition, an aerosol climatology product is generated that contains the physical and optical properties that define the common aerosol types and parameters used in classifying the aerosol composition.

An on-board calibration system is utilized for establishing the quality of MISR fundamental radiance products (Level 1). Strong emphasis is also given to vicarious calibration field missions. A regular program of surface-based vicarious calibration field experiments is planned in coordination with ASTER (A.III.1) and MODIS (A.III.4.a). An airborne simulator instrument has been developed (AirMISR) and is currently being test flown on a high altitude NASA ER-2. Overflights of the vicarious calibration field experiments with this and other imagers (e.g., MAS, AVIRIS, and ASAS) are planned in coordination with AM-1 overpasses.

The MISR Science Team has two basic approaches for validating its Level 2 data products:

- Comparison with measurements obtained during field experiments (AirMISR)
- Comparison with observations from surface-based networks

The MISR Science Team emphasizes the field experiment approach for validation of many of its Level 2 data products. Validation of the aerosol products is of highest priority followed by the surface reflectance products. As with the vicarious calibration activity, the planned field experiments are often coordinated with activities of other EOS Instrument Teams or other programs, e.g., joint missions with the MODIS-Atmosphere Team for validation of the cloud and aerosol products. The table below summarizes the different experiment types in terms of purpose and type of data collected and compared by the MISR Science Team.

MISR Validation Experiment Measurement Comparisons

Experiment Measurement	Inter-Calibration	AirMISR Calibration & TOA Radiance	Algorithm Validation	Product Validation	Vicarious Calibration
MISR [(1)]				X	X
AirMISR [(2)]		X	X	X	X
AVIRIS [(3)]		X			
Networks [(4)]	X		X	X	
MISR Surface	X	X	X	X	X

(5)					

Measurement Key:
1 - Parameters from Level 2 science data products and ancillary data sets.
2 - Parameters retrieved from MISR simulator measurements (AirMISR, ASAS).
3 - Parameters retrieved from AVIRIS measurements.
4 - Parameters retrieved from ground-based networks (ARM, AERONET, ISIS) and other instrument teams.
5 - Parameters retrieved from MISR ground-based instrument measurements.

The MISR Science Team will also utilize aerosol observations obtained by surface-based networks, such as AERONET, for validation of its aerosol products. Surface radiation observations obtained by surface-based networks will also be utilized with particular emphasis on measurements obtained by the ARM site in Oklahoma. Acquisition of correlative measurements of surface reflectance, especially bidirectional reflectance distribution such as also desired by CERES and MODLAND, would also be of significant benefit.

The MISR Science Team has not identified specific needs or requirements for additional validation activity or measurements beyond what is presently planned by them. However, enhancements to their planned efforts might be beneficial. Comparison of MISR-derived products with similar data products generated by other EOS sensors is an area where additional activity would probably be fruitful, e.g., MISR versus MODIS cloud mask or aerosol products.

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A.III.4 MODIS Validation Overview

The Moderate-Resolution Imaging Spectroradiometer (MODIS) instrument on the EOS AM-1 spacecraft is designed to provide long-term observations to derive an enhanced knowledge of global dynamics and processes for the Earth's atmosphere, oceans, and land surfaces. The MODIS instrument has 36 spectral bands ranging from 0.41 to 14.385 μm, a cross-track scan mirror giving a 2,330 km swath width, and spatial resolutions of 250 m (bands 1 - 2), 500 m (bands 3 - 7), and 1000 m (bands 8 - 36).

MODIS validation planning has been developed in 4 teams encompassing calibration, atmosphere, land surface, and ocean data products. Information on the validation plans and

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A.III.4.a MODIS Calibration

MODIS incorporates elaborate on-board calibration systems to ensure the quality of its radiance-at-sensor data products. In addition, the MODIS Calibration Team plans to utilize observations of deep space and the moon during periodic planned spacecraft maneuvers to monitor the performance of the instrument and its calibration processing system. A program of ground-based observations, sponsored by the EOS Project Science Office, is presently underway to characterize the reflectivity of the moon over extended time. The MODIS Science Team also plans a strong vicarious calibration activity in coordination with the ASTER and MISR Science Teams. This involves periodic ground-based measurements at a variety of sites in the western U.S. (see A.III.1 ASTER) in coordination with overpasses of the AM-1 platform and measurements from the high-altitude NASA ER-2 aircraft. Measurements by instruments at the surface and on aircraft are planned for the following parameters: spectral radiance and total irradiance at the surface; surface properties (e.g., spectral reflectance, spectral bidirectional reflectance distribution function, and spectral emissivity and temperature); atmospheric properties (e.g., spectral optical depth, water vapor, ozone, aerosol optical depth, aerosol size distribution and Angstrom coefficient, phase function, and complex index of refraction); and meteorological profiles of temperature and relative humidity. Planned instrumentation on the ER-2 will likely include the MODIS Airborne Simulator (MAS, see EOS Project Science Office homepage under Airborne Information), AirMISR (A.III.3) and other appropriate radiometers.

The MODIS Calibration Team has not identified specific needs or requirements for additional validation activity or measurements beyond what is presently planned by them. However, international participation in the ground-based vicarious calibration field missions is desired so as to enable cross calibration of instruments on multiple satellites. Proposals to support such an activity as well as proposals from U.S. investigators to provide measurements that supplement or significantly enhance the planned MODIS vicarious calibration field missions will be considered.

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A.III.4.b MODIS-Atmosphere

Standard data products generated by the MODIS-Atmosphere Team will characterize the global atmosphere especially the cloud and aerosol constituents thereof.

The MODIS-Atmosphere data products include:

- Cloud mask for distinguishing clear sky from clouds
- Cloud radiative and microphysical properties
  - – Cloud top pressure, temperature, and effective emissivity
  - – Cloud optical thickness, thermodynamic phase, and effective radius
- Aerosol optical properties
  - – Optical thickness over the land and ocean
  - – Size distribution (parameters) over the ocean
- Atmospheric moisture and temperature parameters
- Column water vapor amount

The cloud mask and aerosol products have particular significance for achieving the science objectives of the AM-1 platform. The cloud mask is applied to the Level 1 radiance products prior to producing the land and ocean surface data products. The quality of those products depends on the effectiveness of cloud screening in the data processing. The aerosol retrievals are used to generate atmospheric corrections applied in the derivation of the surface products. The quality of the surface products depends on the quality of the atmosphere corrections. To a lesser extent, the water vapor observations are also used in this way.

For cloud products, the MODIS-Atmosphere validation strategy strongly emphasizes field experiments for the acquisition of correlative measurements. The planned field experiments involve measurements from the MODIS Airborne Simulator (MAS, see EOS Project Science Office homepage under Airborne Information), flown on the NASA ER-2, and other airborne radiometers. There is coordination between the field missions planned by MODIS-Atmosphere and the MISR Science Team and, thus, AirMISR is also expected to be part of the instrument complement in some cases. Active remote sensors, such as cloud lidar, may also be incorporated into the ER-2 payload and future missions may involve a short-wavelength (mm) cloud radar. The field experiments are often coordinated with activities of the NASA Radiation Sciences or other NASA R&A Programs and activities of other agencies. As a result, the observations are coordinated with extensive ground-based observations including active and passive remote sensors and other measurements such as balloon soundings in many cases. For example, field missions will be conducted in coordination with the ARM super site in Oklahoma and the ARM north slope of Alaska site. This strategy is complementary to that adopted by the

CERES Science Team (A.III.2) where greater emphasis is placed on long-term, surface-based observations for validation of its cloud products. It is expected that there will be significant cooperation and synergy between the teams in the validation of their respective cloud products. The planned MODIS Atmosphere field experiments for validation of cloud products encompass a significant range of cloud types and conditions as evident in the table below.

For the aerosol products, the strategy includes occasional field experiments but also relies heavily on regular acquisition of aerosol and water vapor data obtained by ground-based sunphotometer networks, such as AERONET, or networks providing analysis of aerosol samples, such as AEROCE (see Project Science Office homepage under Validation, Networks). AERONET is partially supported by the EOS Project Science Office. The ARM sites also provide appropriate data.

MODIS-Atmosphere Field Campaigns

- Research Program

Mission	Dates	Purpose
SUCCESS	April-May 96	Cirrus cloud properties
TARFOX	July 96	Tropospheric aerosols & cirrus clouds over the ocean
FIRE III	May-June 98	Arctic stratus clouds over sea ice

- MODIS-specific Validation Field Missions

Mission	Dates	Purpose
WINCE	Jan 97	Cloud detection and properties over snow- and ice-covered surfaces
ARM-1	Oct 98	Flights over Southern Great Plains
ARM-2	Apr-May 99	Flights over Southern Great Plains
MOBY	Jan 99	Cirrus & atmos. correction over ocean
California	July 99 Dec 99	Marine stratocumulus and valley fog
Mid-Atlantic	Aug 99	Water vapor, aerosol optical thickness and size distribution
Gulf of Mexico	Jan 00	Clear sky and cirrus clouds, plus sediment outflow from estuaries and biomass burning
California & NW	Sept 00	Fire detection and smoke aerosols

- Selected Ground-based Networks for MODIS-Atmosphere Validation

Measurement	Locations	Primary Purpose
AERONET	US, Japan, South America, Africa, Europe	Aerosol optical thickness and columnar size distribution

ARM	Oklahoma, Alaska, WTP	Cloud properties, sky radiance, temperature and moisture
AEROCE	multiple island locations	Aerosol hydroscopicity, size, scattering and absorption coef.

For the field missions focused on MODIS cloud and aerosol products, *in situ* and/or ground-based measurements of cloud or aerosol properties are desired. Expansion of the present surface-based sunphotometer networks to enhance their global coverage is also a priority. In addition, the MODIS validation program would benefit from extended-time surface-based cloud observations, especially using state-of-the-art active remote sensing techniques, as for CERES (A.III.2). Specifically for the aerosol products, surface-based lidar observations of aerosol vertical profiles over extended time are particularly of interest. Given the overall importance of the MODIS cloud mask and aerosol products, additional investigations to characterize and validate the quality of these products are high priorities. In addition to investigations involving acquisition and analysis of correlative measurements, comparative studies involving products derived from multiple satellite sensors on AM-1 or other satellites are encouraged.

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A.III.4.c MODIS-Land

Land surface data products generated by MODIS-Land (MODLAND) will provide long-term measurements to enhance knowledge of processes occurring on the Earth's land surfaces including land cover changes, vegetation properties and primary productivity. These data are expected to make major contributions to understanding of the Earth's ecosystems and their interaction with other components of the global earth system. In addition to the strong emphasis on terrestrial ecology, land surface temperature and snow and ice cover data products are also generated to further enable quantification of global and regional land-atmosphere interaction. Data products describing fires and the effects thereof are also derived.

MODIS-Land Data Products

- Surface spectral bidirectional reflectance corrected for atmosphere
- Bidirectional reflectance distribution function (BRDF)
- Albedo

- Land surface temperature (day and night)
- Spectral vegetation indices
- Biophysical properties
  - Fraction absorbed photosynthetically-active radiation (FPAR)
  - Leaf area index (LAI)
  - Net primary production (NPP)
- Snow and land cover and land cover change
- Fire, thermal anomalies and burn scars

A wide ranging spectrum of validation activities are planned by the MODIS Science Team for its land surface data products. These include:

- Comparisons with ground-based and in-situ observations
- Comparisons with airborne remote-sensing data
- Intercomparison with data from other AM-1 platform sensors and other satellite systems (Landsat 7, GLI, Spot Vegetation)
- Comparisons with output from radiative transfer models
- Comparisons with output from bio-climatic models
- Investigations over representative range of possible and expected conditions

The MODLAND team has actively participated in field experiments to support development of its algorithms. These experiments typically involve airborne and satellite remote sensing as well as strong efforts to acquire appropriate ground-based correlative measurements, generally in coordination with other NASA R&A programs and/or international multi-agency programs. The MODLAND validation activity will have a similar program as evident in the tables below. It is particularly important that, for the data products related to terrestrial ecology, correlative measurements be collected for a wide variety of distinct biomes over the globe. In addition to the MODIS Airborne Simulator (MAS), AVIRIS and other radiometers will likely be incorporated in some of the planned ER-2 missions (see EOS Project Science homepage under Airborne Information). A MODIS-ASTER airborne simulator (MASTER, see A.III.1) is currently under construction. Other radiometers, such as the Advanced Solid State Array Spectrometer (ASAS), are also candidates for lower altitude aircraft missions. The planned field experiments to validate snow and ice cover as well as the fire data products are generally coordinated with MODIS-Atmosphere validation missions (A.III.4.b).

Planned MODLAND Validation Experiments

Mission	**Dates**	**Aircraft Sensors**	**Primary Purpose**
SNOW (New Hamp., Vermont)	Jan. 1997	MAS, MIR	Snow cover
LBA (Amazonia)* *International approvals required	Sept. 99* *Proposed	MAS & AVIRIS	Dry season tropical forests, cerrado & fire biophysical & surface radiation measurements; LST, land cover, Vegetation Index (VI)

Proposed MODLAND Field and Mini-Experiments

Mission	Dates	Aircraft Sensors	Primary Purpose
California & Western US	June, Dec. , 1997	MAS	LST, VI, land cover, atmospheric correction
California & Western US	Jan, Feb 1998	MAS	LST, snow, landcover, atmospheric correction
Kalahari transect	August 1999	MAS	Fire, scar, arid/semiarid, biophysical, LST
California & Western US	March 2000	MAS	LST, crop, landcover

Of central importance to the MODLAND effort to validate the land data products in the area of terrestrial ecology are the planned comparisons with ground-based and *in situ* observations. Acquisition and analysis of correlative measurements from the full range of basic biome types is a high priority. While a strong emphasis on fundamental remote sensing data products is desired, coordination with observations of carbon and water vapor flux would be very appropriate, especially with measurements from existing tower sites with developed protocols and advanced instrumentation. For example, advantage could be taken of the developing EUROFLUX and AMERIFLUX networks for measurement of carbon fluxes. Enhancement and standardization of the observing capabilities of such sites would be quite beneficial. Similarly, coordination with test sites or observing networks involved in hydrological studies would also be of significant value.

In terms of the fundamental remote sensing products, basic meteorological measurements including sunphotometer observations of aerosol and water vapor loading are of very high priority. Measurements of broadband radiometric fluxes and ultimately the spectral distribution of radiative fluxes are also of high interest. Particularly important is the periodic characterization of the angular distribution of solar radiation reflected from the surface, i.e., the bidirectional reflectance distribution function (BRDF). Innovative and cost effective techniques to provide such measurements for characterizing MODLAND test sites at a scale representative of the satellite sensor footprints are strongly encouraged. Many of these requirements parallel the interests of CERES (A.III.2) as well as MISR (A.III.3) and ASTER (A.III.1) for land surface characterization. Test sites that satisfy the needs of multiple instrument teams for validation of their products are most favored. Similarly, coordination with MOPITT test sites (A.III.5) that provide correlative measurements of CO and other gaseous carbon species would also be advantageous.

Besides the basic radiometric measurements described above, correlative measurements of fundamental biophysical parameters, such as land cover and leaf area index, on an appropriate scale are a very high priority. Again, good coordination with correlative measurements of fundamental radiometric and meteorological parameters is very appropriate. Advantage could also be taken of the activities of other NASA R&A Programs or the projects of other agencies, such as the National Science Foundation (NSF) Long-Term Ecological Research (LTER) sites, or similar international activities. Further elaboration of the vision for an EOS Land Test Site program may be gleaned from a report produced by the EOS Land Test Site Workshop held in 1996. This report is available from the EOS Project Science Office homepage under Validation Documents.

For the land test sites, standardization of observing protocols, instrumentation and instrument calibration are very significant aspects affecting the ultimate utility of correlative measurements for validation of satellite-derived data products. Data management and data access are also significant concerns in this respect. Proposals to provide necessary support in these respects will be considered. Of particular interest are efforts to provide convenient on-line data access where multiple data types, including satellite data, are synthesized into a well-documented, quality-controlled, and easy to use value-added database.

Comparative studies of MODLAND data products and data products generated from other EOS and non-EOS satellite observations are also encouraged.

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A.III.4.d MODIS-Ocean

Products generated by the MODIS-Ocean team (MOCEAN) will characterize the bio-optical properties of the global oceans including the suspended organic and inorganic matter, and ultimately ocean productivity. Sea surface temperature, which plays a major role in air-sea interaction, will also be derived as a standard data product.

The MODIS-Ocean data products are:

- Normalized water leaving radiance (WLR) and aerosol optical depth
- Photosynthetically available irradiance
- Clear water epsilon and aerosol iron content (WRL correction)
- Total ocean pigment, suspended solids, total organic matter concentration and attenuation coefficient
- Chlorophyll fluorescence
- Case 1 and case 2 chlorophyll-a concentration and absorption coefficients
- Coccolith and calcite concentration, pigment concentration in coccolithophore blooms
- Phycoerythrobilin-rich and phycouroblin-rich phycoerythrins
- Ocean productivity
- Sea surface temperature

These are each produced as Level 2 data products. Selected Level 2 products will then be processed to Level 3. A match-up data base is also generated that consists of in-situ

measurements of ocean parameters matched with satellite data. This database will initially be populated with existing ocean surface data matched temporally and spatially with CZCS and AVHRR data, with SeaWiFS data as it becomes available, and with MODIS data after launch.

The accuracy goals adopted by the MODIS Science Team are:

- Water-Leaving Radiance (0.4 - 0.7 m) ± 5%
- Chlorophyll-a (.001- 50 mg m^{-3}) ± 35%
- Sea Surface Temperature ± 0 .3 K

Accurate determination of WLR is the common basis for all the bio-optical algorithms. Of particular interest is the identification of regional and temporal biases and dependencies in the derived data products.

The validation approaches adopted by MOCEAN are:

Sea Surface Temperature

- Top of Atmosphere Radiances: Comparisons with other satellites (AVHRR, ATSR, OCTS, GLI) and aircraft sensors, modeling
- Sea Surface Brightness Temperatures: Focus studies using shipborne (M-AERI, Marine-Atmospheric Emitted Radiation) and airborne (MAS, HIS) sensors,
- Global Bulk Temperature Fields: Comparisons with observations from moorings and drifting buoys (WOCE- TOGA)

Ocean Color

- Validation of Atmospheric Correction: Comparisons with observations of marine and continental aerosols, including lidar observations of absorbing aerosols, and of whitecap, foam and glitter effects.
- Water-Leaving Radiance (Reflectance): Comparisons with in-situ radiance observations. Characterization and calibration of in-situ sensors is an integral component of this activity
- Bio-optical Properties: Comparison with in-situ and airborne remote sensing observations of chlorophyll-a; including colored dissolved organic matter, sediments and phytoplankton absorption; k-490, phycoerythrin, $CaCO_3$, natural chlorophyll fluorescence, and fluorescence efficiency

The MODIS Science Team plans a vigorous validation program for its data products that includes comparison with other satellite sensors, with shipborne and airborne observations, and with buoys and drifters. This may be seen in the following table which briefly summarizes various planned activities. Of particular note is the MODIS/SeaWiFS Ocean Buoy (MOBY) facility that is now deployed off Lanai, HI (see Validation, Test Sites on the EOS Project Science Office homepage). The facility is the centerpiece of MOCEAN efforts to validate WLR.

Especially for ocean color, the MODIS data products and associated planned validation activities must be viewed in the context of the rich mix of new satellite measurements of ocean color, evident in the following table, and associated national and international

validation activities that are presently evolving. NASA is presently forming the Sensor Intercomparison and Merge for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project. This project aims to facilitate the intercomparison of ocean color products derived from various satellite sensors, including MODIS and SeaWiFS. Selections in response to the SIMBIOS NRA will be made shortly. Building on the database activities of SeaWiFS, SIMBIOS seeks to draw together the ocean color validation data generated by the various science teams and provide a community database. MOCEAN will be a partner in this effort. Proposals to the present NRA should enhance and/or complement the activities of MOCEAN and SIMBIOS.

MOCEAN has identified some specific areas where enhancements and complementary activities are needed for validation of MOCEAN data products. These include:

Acquisition of measurements at high latitudes in both hemispheres to establish aerosol effects and hemispheric differences;

Development of low-cost measurement technology for deployment on platforms of opportunity;

Acquisition of meteorological data via sunphotometers and lidars at additional sites;

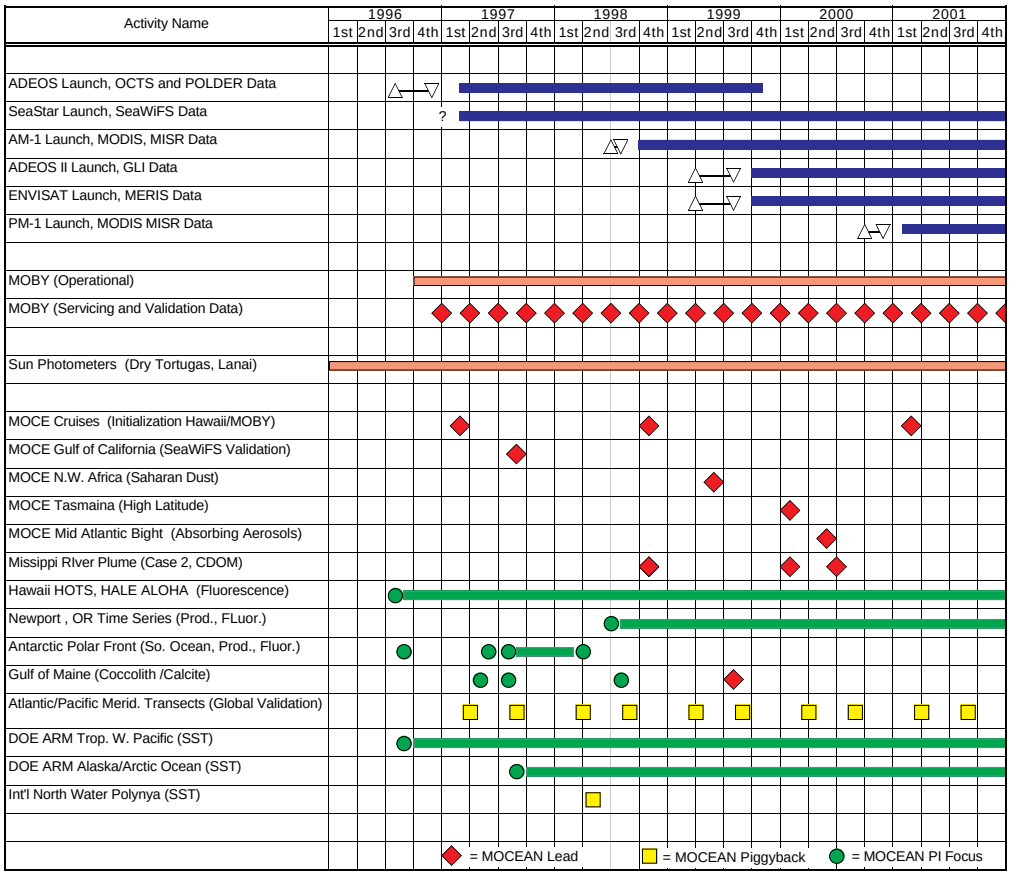
Acquisition of physical observations at bio-optical sites;

Deployment of approximately 100 optical drifters and 100 SST drifters per year;

Acquisition of additional data from Marine-Atmospheric Emitted Radiation Interferometers or equivalent (3-4 units)

In addition MOCEAN calls for continued national/international commitments to existing meteorological (sunphotometers for aerosol observations), TOGA (Tropical Atmosphere-Ocean) moorings, and tide gauge networks.

MOCEAN Validation Activities



Above is a PostScript File, it can be sized without loosing detail, but it must be printed to a PostScript Printer

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A.III.5 MOPITT Validation Overview

The Measurements Of Pollution In The Troposphere (MOPITT) experiment on the EOS AM-1 spacecraft will measure emitted and reflected infrared radiance in the atmospheric column which, when analyzed, permits retrieval of total column and tropospheric profiles of CO and total column CH_4.

MOPITT Standard Data Products are:

- Level 1 data products
  - Calibrated and geo-located radiances

- Level 2 data products
  - CO total column
  - Tropospheric CO profile (average mixing ratio of 3 tropospheric layers)
  - CH_4 total column

- Level 3 data products (experimental at launch)
  - Gridded global CO distribution (global maps).
  - Gridded global CH_4 distribution (global maps).

MOPITT measurements accuracy, precision, and resolution will be confirmed by a combination of the following data validation activities: vigorous pre-launch algorithm test and verification, comparison of MOPITT Level 1 data with model calculations, vicarious calibration using airborne measurements, and comparison of derived data products (Level 2) with correlative measurements. The validation effort will use both ground-based and airborne measurements produced by a correlative measurement team. The validation approach will start with simple situations, such as clear sky over ocean at night, and progress to more complicated cases, such as cloudy conditions over land during daylight. Two airborne instruments, that will support MOPITT validation, are currently under construction: The MOPITT Airborne Test Radiometer (MATR) in the U.S. and the MOPITT-A airborne simulator instrument in Canada.

Planned and/or desired post-launch data validation activities include:

- Level 1 data validation (calibrated radiances)

  (1) Monitoring of all MOPITT calibration events
  (history file accumulated as part of DAAC processing),
  (2) Check of spatial and temporal consistency of observed radiances,
  (3) Comparison of observed radiances with climatological calculations,
  (e.g., CO mixing ratio is nearly constant in the central Pacific),
  (4) Comparison of observed radiances with values calculated from
  correlative measurements,
  (5) Comparison with MOPITT-A measured radiances when underflying
  the EOS/AM-1 platform (vicarious calibration).

- Level 2 data validations (retrieved profiles and column amounts)

  (1) Check of spatial and temporal consistency of retrieved profiles,

(2) Comparison of retrieval gas amounts with climatological data,
(3) Comparison with airborne in-situ observations and with measurements obtained by MOPITT-A and MATR,
(4) Comparison with CO and CH_4 column amounts derived from ground-based FTIR, airborne FTIR (e.g. HIS), and other correlative radiometer measurements,
(5) Comparison with surface-based CO measurements in the boundary layer and free troposphere, especially from mountain top stations.

The MOPITT Science team has identified three specific areas where supplementary support will be needed to fulfill their requirements for correlative measurements and analysis in support of post-launch validation of the MOPITT data products.

• Analysis of ground-based FTIR (Fourier-Transform Infrared Spectroradiometer) measurements and other appropriate radiometric observations to produce correlative measurements of total column CO. For example, FTIR measurements are taken weekly by the Network for Detection of Stratospheric Change (NDSC) comprised of 14 globally distributed sites. Analysis of these and other comparable data to produce an appropriate correlative measurement data set of total column CO and comparison of these data with MOPITT data products is desired.

• Analysis of ground-based measurements of CO concentration obtained at high-altitude (mountain top) stations. For example, continuous measurements of CO concentration are currently made at high-altitude stations located at Mauna Loa, Hawaii; Niwot Ridge, Colorado; the Canary Islands; and Zugspitze, Germany. Analysis of these and other comparable data to produce an appropriate correlative measurement data set of total column CO and comparison of these data with MOPITT data products is desired.

• Collection and analysis of airborne *in situ* measurements of CO and CH_4 concentration profiles. Of particular priority are measurements at selected CMDL Cooperative Networks sites (including Mauna Loa, Hawaii; Chesapeake Bay, Maryland; and Cuiaba, Brazil) and the DOE ARM sites. Also of interest are coincident measured profiles of other species, such as CO_2.

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MOPITT Validation

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A.III.6 LIS Validation Overview

The Lightning Imaging Sensor (LIS), that is scheduled to fly on TRMM in 1997, has been designed to study the distribution and variability of total lightning on a global basis. It consists of a staring imager which is optimized to locate and detect lightning with storm-scale resolution of 5-10 km over a large region (600 x 600 km) of the Earth's surface. The field of view (FOV) is sufficient to observe a point on the Earth or a cloud for 80 seconds, adequate to estimate the flashing rate of many storms. The instrument records the time of occurrence of a lightning event, measures the radiant energy, and estimates the location.

This calibrated lightning sensor uses a wide FOV expanded optics lens with a narrow-band filter in conjunction with a high speed charge-coupled device detection array. A real-time event processor (RTEP) is used to determine when a lightning flash occurs, even in the presence of bright sunlit clouds. Weak lightning signals that occur during the day are hard to detect because of background illumination. The RTEP will remove the background signal, thus, enabling the system to achieve a 90% detection efficiency.

The LIS Validation Strategy includes the following:

- Ground truth observations
- Intensive field experiments
- Aircraft studies (e.g., ER-2 underflight)
- Statistical and objective analyses

Ground truth observations for lightning data will be obtained from:

- Ground-based lightning observations at the TRMM ground truth sites
- Regional lightning networks (e.g., NLDN)
- Time of Arrival (TOA) and sferics networks
- Satellites (e.g., OTD, FORTE, OLS, ALEXIS)
- Interferometers (e.g., SAFIR, NM Tech)
- Airborne (e.g., ER-2) and ground-based optical and electrical observations

Ancillary ground truth data will be obtained from:

- Radar data and products (e.g., TRMM validation sites, WSR-88D sites, etc.)
- Rain gauge data (e.g., TRMM validation sites)
- Satellite data and products (e.g., satellite imagery, precipitation products, etc.)
- Ancillary observations obtained during intensive ground truth field experiments (including ground-based, aircraft, and satellite observations)

Completed field programs being used for pre-launch validation of LIS data products are:

CaPE, Jul-Aug 91, Florida
STORMFEST, Feb-Mar 92, Central U.S.A.
CAMEX 1,2, Sep 93 and Sep 95, East Coast U.S.A.
TOGA COARE, Jan-Feb 93, Tropical Western Pacific Ocean

MCTEX, Nov-Dec 95, Maritime Continent, OTD ground truth
PEM-Tropics, Aug-Oct 96, NO_x assoc. with lightning

Field programs that will be used for post-launch validation of LIS data products are:
TRMM Ground Truth Experiments (Florida/Texas TRMM sites)
ER-2 Underflights for TRMM Ground Truth (Kwajalein, Brazil)

The LIS Science Team has not identified any specific needs or requirements for additional validation activity or correlative measurements beyond what is presently planned by them.

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A.III.7 SAGE III Validation Overview

The first launch of the Stratospheric Aerosol And Gas Experiment III (SAGE III) is scheduled for August 1998 on a Russian Meteor spacecraft. SAGE III takes advantage of both solar and lunar occultation to measure aerosol and gaseous constituents of the atmosphere. SAGE III is an improved extension of the successful Stratospheric Aerosol Measurement II (SAM II), SAGE I, and SAGE II sensors. The additional wavelengths and operation during both lunar and solar occultation that SAGE III provides will improve aerosol characterization; improve the retrievals of O_3, H_2O, and NO_2 concentrations; add retrievals of NO_3 and OClO; extend the vertical range of measurements; provide a self-calibrating instrument independent of any external data needed for retrieval; and expand the sampling coverage.

The SAGE III data products include global profiles of:

Level-1B Transmission Profiles, Solar Events
Aerosol Extinction Profiles & Stratospheric Optical Depth
H_2O Concentration & Mixing Ratio
NO_2 Concentration, Mixing Ratio, & Slant Path Column Amount
NO_3 (Lunar Only) Concentration & Mixing Ratio
O_3 Concentration, Mixing Ratio, & Slant Path Column Amount
OClO (Lunar Only) Concentration & Mixing Ratio
Pressure
Temperature Profile
Cloud Presence

All profiles are provided as functions of altitude, except for the profiles of gaseous constituent mixing ratios that are given as functions of pressure.

The SAGE III Data Validation Program will be patterned after the successful SAM II, SAGE, and SAGE II validation programs, with special efforts devoted to the new measurement capabilities of SAGE III (e.g., aerosol extinction at 757, 872, and 1550 nm, NO_3, OClO, and temperature). As with its predecessors, the SAGE III Data Validation Program is based upon intercomparisons with correlative measurements by *in situ* and remote sensors on the ground, aircraft, balloons, and spacecraft (including other EOS platforms). Intercomparisons consist of two major subdivisions: planned measurements by *in situ* and remote sensors on a single event basis, and intercomparisons with data from other sensors on a statistical or target of opportunity basis. These activities will support the validation of three SAGE III missions: launch of SAGE III on the METEOR 3M spacecraft in August 1998, integration of an instrument on board the International Space Station in 2002, and a Flight of Opportunity mission by 2005. This overview outlines the validation strategy to be applied to the METEOR 3M/SAGE III data products, and should provide a structure that easily translates to the other SAGE III missions. To provide a comprehensive validation, the measurements will be made in both hemispheres, low, middle, and high latitudes, and all representative seasons. A major validation field experiment will be conducted, as soon as possible, after the launch of each SAGE III sensor; other experiments to cover the necessary locations and conditions will be scheduled within the first 18 months of operation, with periodic updates thereafter.

Validation activities envisaged by the SAGE III Science Team include:

- Intercomparison with satellite, balloon, and ground-based measurements as follows:

    - SAGE II intercomparisons
      Other potential satellite missions for intercomparisons are:
      Polar Ozone and Aerosol Measurement II (POAM II), Orbiting Ozone and Aerosol Measurement (OOAM), Improved Limb Atmospheric Spectrometer II (ILAS II), Global Ozone Monitoring by Occultation of Stars (GOMOS), and Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY)

    - Balloon flights for *in situ* stratospheric measurements of aerosols and ozone to altitudes from 25 to 35 km

    - Cooperative networks, e.g., World Meteorological Organization Ozone network, the Network for the Detection of Stratospheric Change (NDSC), the international aerosol lidar community, and NO_2 ground-based measurements over Russia

- Two airborne validation field campaigns currently planned are:

    - Instrument check-out: Alaska, Oct/Nov 1998
      DC-8 with aerosol and ozone lidars and *in situ* instruments

ER-2/WB-57 with *in situ* instruments
Balloon measurements

- Effects of inhomogeneities along slant path: Canada, 1999
  DC-8 with aerosol and ozone lidars and *in situ* instruments
  ER-2 with lidar and *in situ* instruments
  Convair 580 with lidar and *in situ* instruments

The SAGE III Validation Program has requirements for supplementary correlative measurements that may be obtained on a cooperative basis by individual investigators or institutions not funded directly by the SAGE III project. Correlative measurements are desired from the networks that measure the same atmospheric species as those measured by SAGE III, e.g., the Network for the Detection of Stratospheric Change (NDSC), the High Latitude European Network (HLEN), and others. Of particularly interested are high latitude balloon campaigns and other correlative measurements that could be conducted jointly for validation of SAGE III and other similar satellite missions, such as ILAS (Improved Limb Atmospheric Spectrometer) on board ADEOS and a follow-on ADEOS II in 1999. ILAS, like SAGE III, employs the occultation technique and the two sensors measure common atmospheric species. Other measurements from balloons that would be very useful for validating SAGE III, including balloon ozone sondes and dustsondes for aerosol measurements. Balloon borne dustsondes have been one of the core aerosol sensors used for validation of the family of SAGE instruments which includes SAM II, SAGE and SAGE II. The SAGE III project intends to provide limited funding for dustsonde measurements during dedicated campaigns with aircraft. But more extensive periodic dustsonde measurements (on an annual basis) are needed, at least for the first two or three years after launch. Also of interest are aircraft remote sensing and *in situ* measurements of key atmospheric species, e.g., aerosols, ozone, and water vapor, during planned SAGE III airborne campaigns.

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Appendix B

Instructions for Responding to NASA Research Announcements

(JULY 1995)

1. Foreword

a. These instructions apply to NASA Research Announcements. The "NASA Research Announcement (NRA)" permits competitive selection of research projects in accordance with statute while preserving the traditional concepts and understandings associated with NASA sponsorship of research.

b. These instructions are Appendix I to 1870.203 of the NASA Federal Acquisition Regulation Supplement.

2. Policy

a. Proposals received in response to an NRA will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

b. A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

3. Purpose

These instructions supplement documents identified as "NASA Research Announcements." The NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

4. Relationship to Award

a. A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument.

b. Grants are generally used to fund basic research in educational and nonprofit institutions, while research in other private sector organizations is accomplished under contract. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR Supplement (NHB 5100.4). Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NHB 5800.1).

5. Conformance to Guidance

a. NASA does not have mandatory forms or formats for preparation of responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

b. In order to be considered responsive, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

6. NRA-Specific Items

a. Several proposal submission items appear in the NRA itself. These include: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

7. Proposal Contents

a. The following information is needed in all proposals in order to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

b. Transmittal Letter or Prefatory Material.

(1) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(2) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(3) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(4) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(5) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(6) Identification of the NRA, by number and title, to which the proposal is responding;

(7) Dollar amount requested , desired starting date, and duration of project;

(8) Date of submission; and

(9) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

c. Restriction on Use and Disclosure of Proposal Information

Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information. The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

d. Abstract. Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

e. Project Description. (1) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(2) When it is expected that the effort will require more than one year for completion, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should, of course, be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

f. Management Approach. For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described. Intensive working relations with NASA field centers that are not logical inclusions elsewhere in the proposal should be described.

g. Personnel. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other

scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

h. Facilities and Equipment. (1) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use.

(2) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

i. Proposed Costs. (1) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all manpower data in terms of man-months or fractions of full-time.

(2) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self- evident. List estimated expenses as yearly requirements by major work phases. (Standard Form 1411 may be used).

(3) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 18-31 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

j. Security. Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

k. Current Support. For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

l. Special Matters. (1) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(2) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

8. Renewal Proposals

a. Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information

that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

b. NASA may renew an effort either through amendment of an existing contract or by a new award.

9. Length

Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments: their availability may be mentioned in the proposal.

10. Joint Proposals

a. Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

b. Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

11. Late Proposals

A proposal or modification received after the date or dates specified in an NRA may be considered if the selecting official deems it to offer NASA a significant technical advantage or cost reduction.

12. Withdrawal

Proposals may be withdrawn by the proposer at any time. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

13. Evaluation Factors

a. Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

b. Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

c. Evaluation of its intrinsic merit includes the consideration of the following factors, none of which is more important than any other:

(1) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(2) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(3) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(4) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

d. Evaluation of the cost of a proposed effort includes the realism and reasonableness of the proposed cost and the relationship of the proposed cost and available funds.

14. Evaluation Techniques

Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of- interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

15. Selection for Award

a. When a proposal is not selected for award, and the proposer has indicated that the proposal is not to be held over for subsequent reviews, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

b. When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model contract and other information which will be of use during the contract negotiation.

16. Cancellation of NRA

NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation. Cancellation may be followed by issuance and synopsis of a revised NRA, since amendment of an NRA is normally not permitted.

Appendix C

Guidelines for International Proposals

NASA accepts proposals from entities located outside the U.S. in response to this NRA. Proposals from non-U.S. entities should not include a cost plan. Non-U.S. proposals, and U.S. Proposals that include non-U.S. participation, must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. Such endorsement should indicate the following points: (1) The proposal merits careful consideration by NASA; and (2) If the proposal is selected, sufficient funds will be made available by the sponsoring foreign agency to undertake the activity as proposed.

Proposals, along with the requested number of copies and Letter of Endorsement must be forwarded to NASA in time to arrive before the deadline established for this NRA. In addition, one copy of each of these documents should be send to:

NASA Headquarters
Office of External Relations
Mission to Planet Earth Division
Mail Code IY
Washington, DC 20546
USA

Any materials sent by courier or express mail (e.g., Federal Express) should be sent to:

NASA Headquarters
Office of External Relations
Mission to Planet Earth Division
Mail Code IY
300 E Street, SW
Washington, DC 20024-3210

All proposals must be typewritten in English. All non-U.S. proposals will undergo the same evaluation and selection process as those originating in the U.S. Non-U.S. proposals and U.S. Proposals that include non-U.S. participation, must follow all other guidelines and requirements described in this NRA. Sponsoring non-U.S. agencies may, in exceptional situations, forward a proposal without endorsement to the above address, if review and endorsement are not possible before the announced closing date. In such cases, however, NASA's Mission to Planet Earth Division of the Office of External Relations should be advised when a decision on the endorsement is to be expected.

Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating the NRA. Copies of these letters will be sent to the sponsoring government agency.

Appendix D

Proposal Cover Sheet, Formats, Forms, and Required Declarations

Proposal Cover Sheet
NASA Research Announcement 97-MTPE-03

Proposal No. _____ (Leave Blank for NASA Use)

Title: _____

Principal Investigator:

Name:_____

Department:_____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators: Name Institution Telephone

_____ _____ _____
_____ _____ _____

Budget:
1st Year: _____ 2nd Year: _____ 3rd Year: _____

Total:_____

Program Area:

I. R & A Program Research _____
II. EOS Validation _____

Authorizing Official: _____ _____
(Name) (Institution)

Proposal Summary (1-page only)

NASA Research Announcement 97-MTPE-03

PRINCIPAL INVESTIGATOR
(Name, Address,
Telephone, Email)

Co-INVESTIGATORS:
(Name and Affiliation Only)

PROPOSAL TITLE:

PROPOSAL COST: Yr1 Yr2 Yr3

ABSTRACT: (Single-space, typed). Include: (a) Objectives and justification for work; (b) Accomplishments of prior year's work; (c) Outline of proposed work and methodology; (d) One or two relevant recent publications authored by the PI or Co-I. **DO NOT USE ADDITIONAL SHEETS**.

Current And Pending Research Support
From All Other Sources

All proposals must include this information. This list should include all current and pending research support from the following sources:

1. Any proposal for which the PI of this proposal is also the Principal Investigator.

2. Any proposal, regardless of the PI, which accounts for more than 20% of the time of the Principal Investigator of this proposal and other personnel essential to this proposal.

Please provide this information in the following format:

I. Principal Investigator

A. Current FY 97 Support

1. Source of Support and Principal Investigator
2. Award Amount and Period of Performance
3. Person-Months and Level of Effort
4. Project Title and Short Abstract (50 words or less)

B. Pending Proposals (Excluding this proposal but including other proposals).

1. Source of Support and Principal Investigator
2. Award Amount and Period of Performance
3. Person-Months and Level of Effort
4. Project Title and Short Abstract (50 words or less)

For both current and pending support provide information on:

II. Co-Investigators

As outlined above, provide information on all Current and Pending Support. Disclosure of current and pending research support is not required for collaborators.

III. Other agencies to which this proposal, or parts thereof, has been submitted.

Certification Regarding
Debarment, Suspension, and Other Responsibility Matters
Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211). Copies of the regulation may be obtained by contracting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, DC. 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statues or commission of embezzlement theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name PR/Award Number or Project Name

Name and Title of Authorized Representative

Signature Date

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register , require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or governmentwide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about -

(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs, and
(4) The penalties that may be imposed upon employees for drug abuse violations in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will -

(1) Abide by the terms of the statement; and
(2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2) , with respect to any employee who is so convicted -

(1) Taking appropriate personnel action against such an employee, up to and including termination; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

Name and Title of Authorized Representative

Signature

Date

CERTIFICATION REGARDING LOBBYING

Certification for Contracts, Grants, Loans, and Cooperative Agreements.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000, and not more than $100,000 for each such failure.

Signature and Date

Name and Title of Authorized Representative

Organization Name

Appendix E
Airborne Science Points-of-Contact and Flight Cost Estimates

The following is the guidance provided by NASA to potential users of NASA aircraft for Earth science measurements in FY97. Guidance for FY98 is not yet available but is expected to be similar. Investigators proposing usage of NASA aircraft resources should file the appropriate flight requests and budget accordingly, i.e., sensor support and maintenance, flight hour costs and realistic mission peculiar costs.

"NASA's Mission to Planet Earth Office is currently developing plans for its FY 1997 Airborne Science Program.

PLEASE NOTE the major changes to program implementation beginning in FY 1997. As part of Center role changes, NASA intends to consolidate its research and program support aircraft to its Dryden Research Center, Edwards AFB, CA. Budget realities have forced a number of reductions in the airborne program, and each investigator must carefully determine the priorities for each flight request. The investigator/science team has responsibility for sensor support and maintenance, and for planning purposes, each investigator should plan on paying the cost of aircraft operations (no subsidized flight hours).

The core fleet consists of two ER-2's and one each DC-8, C-130Q, P-3B, and a T-39. The airborne program office is currently evaluating airborne science requirements and the fleet mix **may** change. The program is cooperating with other federal agencies and will off load some requirements to them. Concequently, please be as flexible as you can when filling out your flight request.

> **A flight request must be submitted directly to ARC – Aircraft Program Office in response to this letter. Because of the major changes in the airborne program, NO LATE flight requests will be accepted.**
>
> **Personel from Ames, Dryden, Wallops, and Headquarters will prepare the FY 1997 flight schedule during the summer, prior to the physical move to Dryden**
>
> **Return the completed flight request form no later than June 7, 1996.**

Completed flight requests and any supporting documentation are to be sent to:

> National Aeronautics and Space Administration
> Ames Research Center
> MS 211-17
> Moffet Field, CA 94035-1000

In addition to planning for full flight hour and instrument operation costs, investigators will be assessed special mission peculiar costs for any missions that have unique requirements (e.g. deployments, facilities usage). To determine these costs for budgetary planning please consult with the respective NASA points of contact:

ER-2:	John C. Arvesen	415-604-5376
DC-8:	George Alger	415-604-5338
C-130Q, P-3B, T-39	Ed Melson	804-824-1306

While flight hour costs remain unidentified, for planning purposes use the following Flight hour costs:

ER-2	$3,500/hour
DC-8:	$4,500/hour
P-3B:	$3,000/hour
C-130Q:	$3,000/hour
T-39	$1,500/hour

Thank you for your cooperation. FY 1997 may be a difficuly year, but we are hopeful that in subsequent years implementation of the flight season will proceed smoothly."

Appendix F
List of Acronyms Used in this Research Announcement

ADEOS	Advanced Earth Observing System (Japanese)
AEROCE	Atmosphere/Ocean Chemistry Experiment
AERONET	Aerosol Robotic Network
AirMISR	Airborne MISR simulator
ARC	Ames Research Center
ARM	Atmospheric Radiation Measurement (DOE Program)
ASAS	Advanced Solid-state Array Spectrometer
ASTER	Advanced Spaceborne Thermal Emission And Reflection Radiometer
ATBD	Algorithm Theoretical Basis Document
ATSR	Along-Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AVIRIS	Airborne Visible/Infrared Imaging Spectroradiometer
BALTEX	Baltic Sea Experiment
BOREAS	Boreal Ecosystem-Atmosphere Study
BRDF	bidirectional reflectance distribution function
BRF	bidirectional reflectance
BSRN	Baseline Surface Radiation Network
CAGEX	CERES-ARM-GEWEX Experiment
CAMEX	Convection and Atmosphere Moisture Experiment
CaPE	Convection and Precipitation/Electrification Experiment
CERES	Clouds and the Earth's Radiant Energy System
CMDL	NOAA Climate Monitoring and Diagnostics Laboratory
CZCS	Coastal Zone Color Scanner
DAAC	Distributed Active Archive Center
DMSP	Defense Meteorological Satellite Program
DOE	U.S. Department of Energy
EOS	Earth Observing System
ERBE	Earth Radiation Budget Experiment
ERS	Earth Resources Satellite
FIRE	First ISCCP Regional Experiment
FOV	field of view
FPAR	fraction absorbed of photosynthetically active radiation
FTIR	Fourier-Transform Infrared Radiometer
FY	fiscal year
FY-2	Fengyun-2 (Chinese geostationary weather satellite)
GCIP	GEWEX Continental-scale International Project
GCM	General Circulation Model
GEBA	Global Energy Balance Archive
GEWEX	Global Energy and Water Cycle Experiment
GLAS	Geosciences Laser Altimeter
GLI	Global Imager
GMS	Geosynchronous Meteorological Satellite (Japanese)
GOES	Geostationary Operational Environmental Satellite
GOMOS	Global Ozone Monitoring by Occultation of Stars
GOMS	Geosynchronous Operational Meteorological Satellite (Russian)

GVAP	GEWEX Water Vapor Project
HIS	High-resolution Interferometer Sounder
HLEN	High Latitude European Network
ILAS	Improved Limb Atmospheric Spectrometer
INSAT	Indian Geostationary Satellite
ISCCP	International Satellite Cloud Climatology Project
ISIS	Integrated Surface Irradiance Study
JERS	Japanese Earth Remote-Sensing Satellite
LAI	leaf area index
LBA	Large Scale Biosphere Atmosphere Experiment in Amazonia
LCLUC	Land-Cover and Land-Use Change
LIS	Lightning Imaging Sensor
LST	land surface temperature
LTER	Long-Term Ecological Research
M-AERI	Marine-Atmospheric Emitted Radiation Instrument
MAS	MODIS Airborne Simulator
MASTER	MODIS-ASTER airborne simulator
MATR	MOPITT Airborne Test Radiometer
MCTEX	Marine Continent Thunderstorm Experiment
MERIS	Medium-Resolution Imaging Spectrometer
METEOR 3M-1	Russian Operational Weather Satellite
METEOSAT	European Geostationary Meteorological Satellite
MIR	Microwave Imaging Radiometer
MISR	Multi-Angle Imaging Spectroradiometer
MOBY	Marine Optical Buoy
MOCEAN	MODIS-Ocean
MODIS	Moderate-Resolution Imaging Spectroradiometer
MODLAND	MODIS-Land
MOPITT	Measurements Of Pollution In The Troposphere
MOPITT-A	MOPITT Airborne simulator
MTPE	Mission to Planet Earth
NASA	U.S. National Aeronautics and Space Administration
NDSC	Network for the Detection of Stratospheric Change
NLDN	National Lightning Detection Network
NOAA	U.S. National Oceanic and Atmospheric Administration
NPOESS	National Polar Orbiting Environmental Satellite System
NPP	net primary production
NRA	NASA Research Announcement
NSF	National Science Foundation
OCTS	Ocean Color and Temperature Scanner
OLS	Optical Line Scanner
OMB	U.S. Office of Management and Budget
OOAM	Orbiting Ozone and Aerosol Measurement
OTD	Optical Transient Detector
PEM	Pacific Exploratory Mission
PI	Principal Investigator
POAM	Polar Ozone and Aerosol Measurement
POLDER	Polarization and Directionality of Earth's Reflectance instrument
R&A	Research and Analysis

RTEP	real-time event processor
SAFIR	Satellite for Information Relay
SAGE	Stratospheric Aerosol And Gas Experiment
SAM	Stratospheric Aerosol Measurement
SCF	Science Computing Facility
SCIAMACHY	Scanning Imaging Absorption Spectroradiometer for Atmospheric Cartography
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SFC	surface
SIMBIOS	Sensor Intercomparison and Merge for Biological and Interdisciplinary Oceanic Studies
SPOT	Système Pour l'Observation de la Terre (French)
SSM/I	Special Sensor Microwave/Imager
SSM/IS	Special Sensor Microwave/Imager Sounder
SSM/T	Special Sensor Microwave/Temperature (sounder)
SSM/T2	Special Sensor Microwave/Temperature (sounder)
SST	sea surface temperature
STORMFEST	Storm-scale Operational and Research Meteorology - Fronts Experiment Systems Test
SUCCESS	Subsonic Aircraft: Contrail and Cloud Effects Special Study
SWIR	short wave infrared
TARFOX	Tropospheric Aerosol Radiative Forcing Observational Experiment
3-D	Three-dimensional
TIR	thermal infrared
TMI	TRMM Microwave Imager
TOA	top-of-atmosphere
TOGA	Tropical Ocean Global Atmosphere experiment
TRMM	Tropical Rainfall Measurement Mission
U.S.	United States
VI	vegetation index
VIRS	Visible and Infrared Sensor
VNIR	visible and near infrared
WINCE	Winter Cloud Experiment
WLR	water leaving radiance
WOCE	World Ocean Circulation Experiment
XBT	Expendable Bathy-Thermograph